

Nuclide Mixtures / Mass Activity Converter

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Nuclide Mixtures:

- Why mixtures ?
 - Mixture vs. simple nuclide
 - in the real life: mainly mixtures
- Often-used module in other applications

Go to Nuclide Mixtures Application...

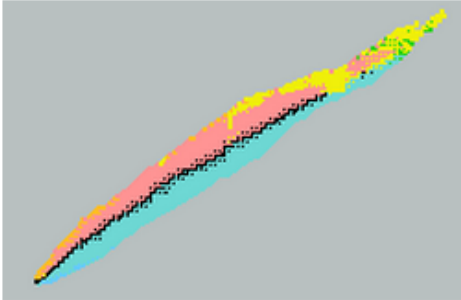
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... web driven nuclear science


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 Nuclear Data Retrieval



> Application Centre

- » Mass Activity Calculator, **New:** Mass Activity Converter
- » Decay Engine
- » Dosimetry & Shielding
- » Range & Stopping Power
- » In Silico Dosimetry
- » webKORIGEN
- » Decay Engine for Large Nuclide Sets
- » Universal Nuclide Chart
- » Transport & Packaging
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- » Nucleonica Scripting
- » Radiological Dispersion Module
- » Gamma Spectrum Generator
- » Gamma Spectrum Generator Pro
- » Virtual Cloud Chamber
- » Geant4 Dosimetry
- » easy Monte Carlo
- » Cambio file Converter
- » WESPA
- » Gamma Library
- » webGraph

Welcome, Joseph

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Networking

> My Last Nuclides

- » 27 Co60
- » 55 Cs137
- » 94 Pu239
- » 92 U235
- » 88 Ra226

> My Nuclide Mixtures

- » **Natural Uranium**
- » Fukushima II
- » Fukushima spectrum
- » Transuranics in 1 ton Spent Fuel
- » Fukushima

> My Sources

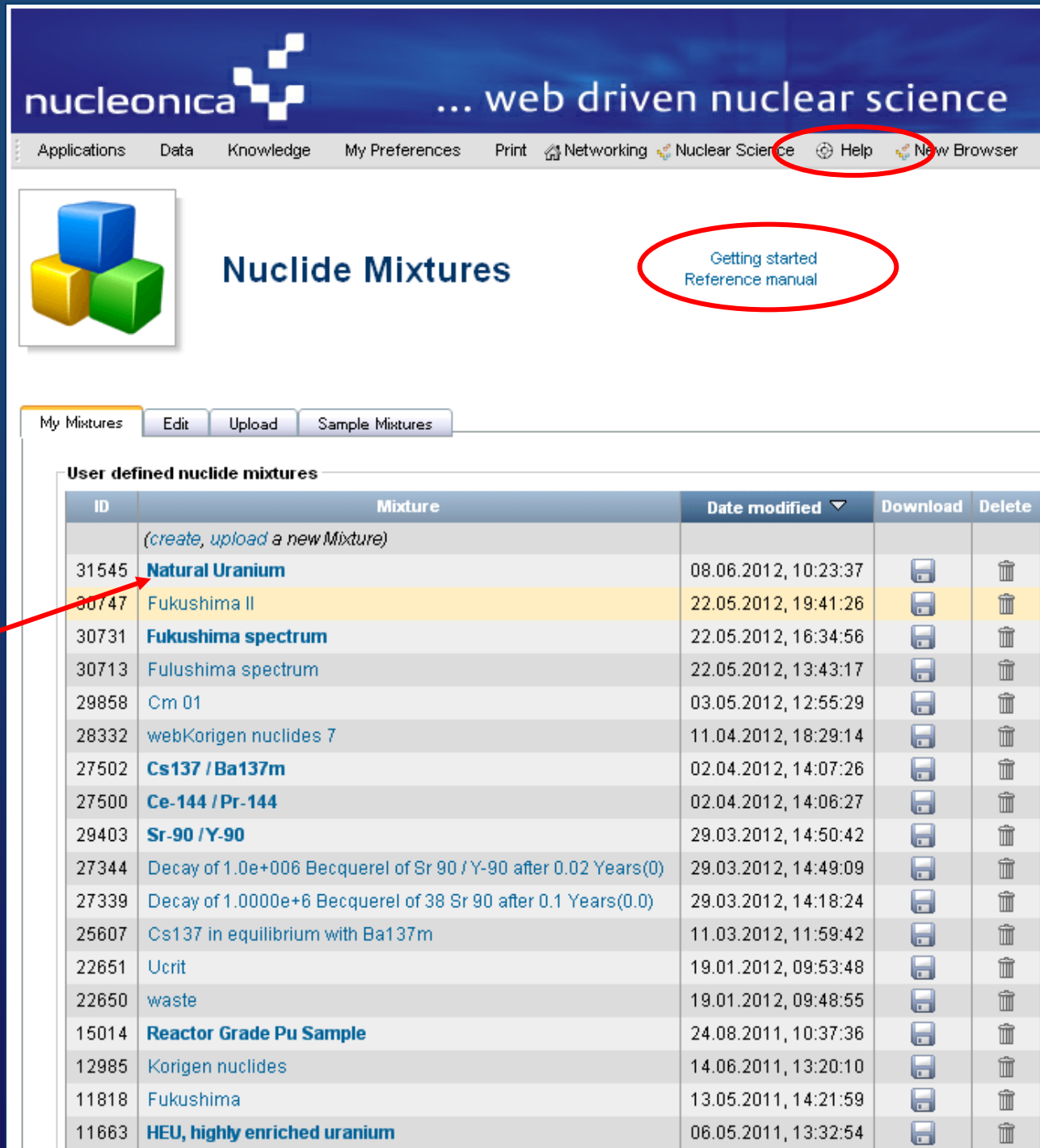
- » testco
- » Pu241 with daughters
- » Pu241 - 15mg - 8y old - solid, non-special form
- » Uranium metal
- » Uranium.xml
- » Pu239 1 g

My Mixtures

Nuclide mixtures in
bold are Sample
Mixtures


Other mixtures are
user created

To edit click on
mixture...



nucleonica ... web driven nuclear science

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 Nuclide Mixtures [Getting started Reference manual](#)

My Mixtures Edit Upload Sample Mixtures

User defined nuclide mixtures

ID	Mixture	Date modified ▾	Download	Delete
	<i>(create, upload a new Mixture)</i>			
31545	Natural Uranium	08.06.2012, 10:23:37		
30747	Fukushima II	22.05.2012, 19:41:26		
30731	Fukushima spectrum	22.05.2012, 16:34:56		
30713	Fukushima spectrum	22.05.2012, 13:43:17		
29858	Cm 01	03.05.2012, 12:55:29		
28332	webKorigen nuclides 7	11.04.2012, 18:29:14		
27502	Cs137 / Ba137m	02.04.2012, 14:07:26		
27500	Ce-144 / Pr-144	02.04.2012, 14:06:27		
29403	Sr-90 / Y-90	29.03.2012, 14:50:42		
27344	Decay of 1.0e+006 Becquerel of Sr 90 / Y-90 after 0.02 Years(0)	29.03.2012, 14:49:09		
27339	Decay of 1.0000e+6 Becquerel of 38 Sr 90 after 0.1 Years(0.0)	29.03.2012, 14:18:24		
25607	Cs137 in equilibrium with Ba137m	11.03.2012, 11:59:42		
22651	Ucrit	19.01.2012, 09:53:48		
22650	waste	19.01.2012, 09:48:55		
15014	Reactor Grade Pu Sample	24.08.2011, 10:37:36		
12985	Korigen nuclides	14.06.2011, 13:20:10		
11818	Fukushima	13.05.2011, 14:21:59		
11663	HEU, highly enriched uranium	06.05.2011, 13:32:54		

Nuclide mixtures

Wiki page (Help)

Full technical documentation

h nucleonica

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Level: Intermediate, Advanced

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1.1.2.1 Input Numbers of Atoms

1.1.2.2 Input Masses

1.1.2.3 Input Activities

1.1.3 Half-Life of the Virtual Parent, t_V

1.1.4 Daughters of the Virtual Nuclide, P_1 , Q_1 , R_1

1.1.5 Branching Ratios, BR

1.1.6 Atomic Mass of the Virtual Nuclide, M_V

1.1.7 Conversion Half-Life of the Virtual Nuclide, $conT$

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Nuclide Mixtures

In this chapter the formalism for calculations on mixtures of nuclides is developed. In particular the formalism for the radioactive decay of nuclide mixtures. A virtual parent is defined which decays on a time-scale required mixture. The procedure for obtaining the half-life, the daughters, the branching ratios,

Edit

Nuclide Mixture
example:
natural uranium



Nuclide Mixtures

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[Reference manual](#)

My Mixtures
Edit
Upload
Sample Mixtures

Name

Description:

1 mole natural uranium (U234, U235, U238) with isotopes fractions corresponding to the abundancies

Nuclide ▲	Activity(Bq)	Mass(g)	Number of Atoms	Mass ratio	Mole ratio	Activity ratio	Delete
<i>(add a new Nuclide)</i>							
92 U 234	2.907e+6	0.01264	3.252e+19	5.310e-5	5.400e-5	0.4860	
92 U 235	1.354e+5	1.693	4.338e+21	7.114e-3	7.204e-3	0.02264	
92 U 238	2.939e+6	236.3	5.978e+23	0.9928	0.9927	0.4913	
Total: 3	5.981e+6	238.0	6.022e+23	1.000	1	1	

Element

Mass

Quantity

Unit

Gram
 Gram
 Becquerel
 Curie
 Number of Atoms
 Mole

Significant figures:

Create

a new mixture:






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My Mixtures Edit Upload Sample Mixtures

User defined nuclide mixtures

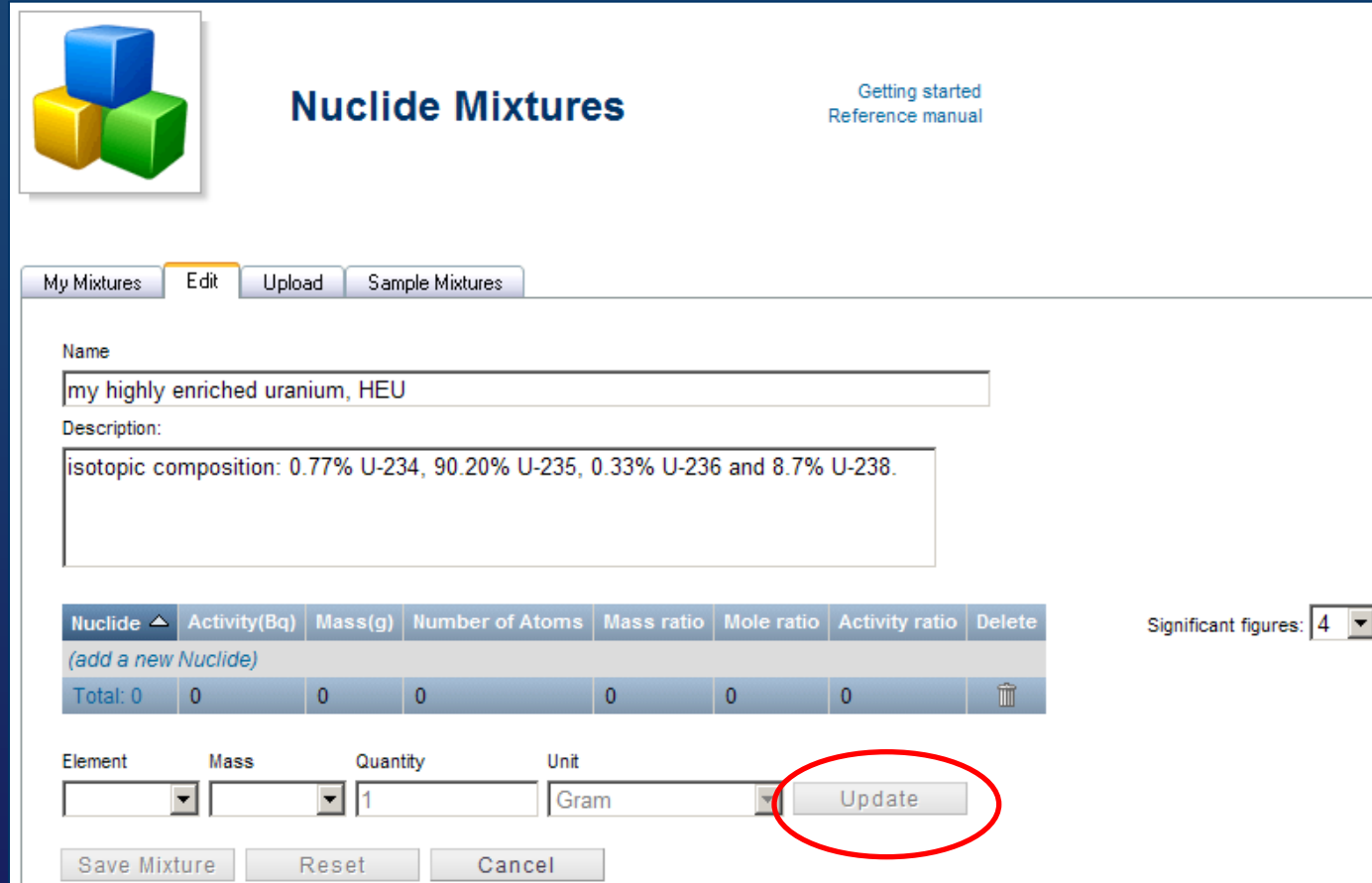
ID	Mixture	Date modified ▼	Download	Delete
	(create, upload a new Mixture)			
31545	Natural Uranium	08.06.2012, 10:23:37		
30747	Fukushima II	22.05.2012, 19:41:26		
30731	Fukushima spectrum	22.05.2012, 16:34:56		
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27500	Ce-144 / Pr-144	02.04.2012, 14:06:27		
29403	Sr-90 / Y-90	29.03.2012, 14:50:42		
27344	Decay of 1.0e+006 Becquerel of Sr 90 / Y-90 after 0.02 Years(0)	29.03.2012, 14:49:09		
27339	Decay of 1.0000e+6 Becquerel of 38 Sr 90 after 0.1 Years(0.0)	29.03.2012, 14:18:24		
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12985	Korigen nuclides	14.06.2011, 13:20:10		
11818	Fukushima	13.05.2011, 14:21:59		
11663	HEU, highly enriched uranium	06.05.2011, 13:32:54		

Create a new mixture:

Details

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1. In Edit tab, enter a **name** for the mixture
2. Enter short description
3. Enter components → „(add a new nuclide)“
 - Choose a nuclide
 - Select a unit
 - Enter the quantity
 - Update grid
4. Save the mixture



The image shows the 'Nuclide Mixtures' application interface. At the top, there is a logo with three colored cubes (blue, yellow, green) and the title 'Nuclide Mixtures'. To the right of the title are links for 'Getting started' and 'Reference manual'. Below the title, there are four tabs: 'My Mixtures', 'Edit', 'Upload', and 'Sample Mixtures'. The 'Edit' tab is currently selected. The 'Edit' form contains a 'Name' field with the text 'my highly enriched uranium, HEU' and a 'Description' field with the text 'isotopic composition: 0.77% U-234, 90.20% U-235, 0.33% U-236 and 8.7% U-238.'. Below the description is a table with columns: 'Nuclide', 'Activity(Bq)', 'Mass(g)', 'Number of Atoms', 'Mass ratio', 'Mole ratio', 'Activity ratio', and 'Delete'. The table has a row for 'Total: 0' and a row for '(add a new Nuclide)'. To the right of the table is a 'Significant figures' dropdown menu set to '4'. At the bottom of the form, there are four input fields: 'Element', 'Mass', 'Quantity', and 'Unit'. The 'Quantity' field has the value '1'. The 'Unit' field has the value 'Gram'. To the right of these fields is an 'Update' button, which is circled in red. Below the input fields are three buttons: 'Save Mixture', 'Reset', and 'Cancel'.

Nuclide Mixtures

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Reference manual

My Mixtures Edit Upload Sample Mixtures

Name
my highly enriched uranium, HEU

Description:
isotopic composition: 0.77% U-234, 90.20% U-235, 0.33% U-236 and 8.7% U-238.

Nuclide ▲	Activity(Bq)	Mass(g)	Number of Atoms	Mass ratio	Mole ratio	Activity ratio	Delete
(add a new Nuclide)							
Total: 0	0	0	0	0	0	0	

Significant figures: 4 ▼

Element Mass Quantity Unit

Update

Save Mixture Reset Cancel

Create a new mixture:

Details

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My Mixtures Edit Upload Sample Mixtures

Name

my highly enriched uranium, HEU

Description:

isotopic composition: 0.77% U-234, 90.20% U-235, 0.33% U-236 and 8.7% U-238.

Nuclide ▲	Activity(Bq)	Mass(g)	Number of Atoms	Mass ratio	Mole ratio	Activity ratio	Delete
<i>(add a new Nuclide)</i>							
92 U 238	4.277e-17	3.439e-21	8.700	0.08802	0.087	5.940e-4	
92 U 236	3.058e-16	1.293e-22	0.33	3.310e-3	3.300e-3	4.248e-3	
92 U 235	2.815e-15	3.521e-20	90.20	0.9010	0.902	0.03910	
92 U 234	6.883e-14	2.992e-22	0.7700	7.659e-3	7.700e-3	0.9561	
Total: 4	7.200e-14	3.907e-20	100.0	1	1	1	

Significant figures:

Element

Mass

Quantity

Unit

Gram

Update

Save Mixture

Reset

Cancel



Nuclide Mixtures

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My Mixtures

Edit

Upload

Sample Mixtures

Name

HEU, highly enriched uranium

Description:

isotopic composition: 0.77% U-234, 90.20% U-235, 0.33% U-236 and 8.7% U-238.

Nuclide	Activity(Bq)	Mass(g)	Number of Atoms	Mass ratio	Mole ratio	Activity ratio	Delete
<i>(add a new Nuclide)</i>							
92 U 234	6.88347e-14	2.99248e-22	0.770000	7.65876e-3	0.0077	0.956060	
92 U 235	2.81501e-15	3.52050e-20	90.2000	0.901014	0.902000	0.0390983	
92 U 236	3.05835e-16	1.29348e-22	0.330000	3.31044e-3	3.30000e-3	4.24781e-3	
92 U 238	4.27690e-17	3.43905e-21	8.70000	0.0880167	0.087	5.94028e-4	
Total: 4	7.19983e-14	3.90727e-20	100.000	1.00000	1.00000	1	

Element

Mass

Quantity

Unit

1e3

Gram

Update

Save Mixture

Reset

Cancel

Gram
Gram
Becquerel
Curie
Number of Atoms
Mole

Save as Sample

Rescale feature...

Rescale results

for example

from 100 atoms to 1 kg!

Sample Mixtures: Pre-defined Mixtures



Nuclide Mixtures

My Mixtures Edit Upload Sample Mixtures

Select	Sample Mixture Name	Date Modified	Delete
<input checked="" type="checkbox"/>	Ce-144 / Pr-144	02.04.2012, 14:06:35	
<input checked="" type="checkbox"/>	Cs137 / Ba137m	02.04.2012, 14:07:29	
<input checked="" type="checkbox"/>	Fukushima spectrum	22.05.2012, 16:35:01	
<input checked="" type="checkbox"/>	HEU, highly enriched uranium	06.05.2011, 13:32:54	
<input checked="" type="checkbox"/>	I131_Cs137_mixture	14.03.2011, 16:22:45	
<input checked="" type="checkbox"/>	Natural Thorium	10.03.2010, 13:36:26	
<input checked="" type="checkbox"/>	Natural Uranium	08.04.2010, 15:50:06	
<input checked="" type="checkbox"/>	Rb-81/Kr-81m Generator	06.01.2011, 17:03:59	
<input checked="" type="checkbox"/>	Reactor Grade Pu Sample	10.05.2011, 13:33:12	
<input checked="" type="checkbox"/>	Sr-90 / Y-90	29.03.2012, 14:51:09	
<input checked="" type="checkbox"/>	Transuranics in 1 ton Spent Fuel	10.03.2010, 14:31:18	
<input checked="" type="checkbox"/>	U232+Co60	10.03.2010, 13:50:08	

Send to My Mixtures

Create a new mixture: Save & Download mixture

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The screenshot displays the 'My Mixtures' interface with the 'Edit' tab selected. The 'Name' field contains 'my highly enriched uranium, HEU' and the 'Description' field contains 'isotopic composition: 0.77% U-234, 90.20% U-235, ...'. Below these fields is a table of nuclides:

Nuclide	Activity(Bq)	Mass(g)	Number of Atoms
92 U 234	1.762e+6	7.659e-3	1.971e+19
92 U 235	7.205e+4	0.9010	2.309e+21
92 U 236	7.827e+3	3.310e-3	8.446e+18
92 U 238	1.095e+3	0.08802	2.227e+20
Total: 4	1.843e+6	1	2.559e+21

At the bottom, there are input fields for 'Element', 'Mass', 'Quantity' (set to 1), and 'Unit' (set to 'Gra'). The 'Save Mixture' button is circled in red. A red arrow points from this button to the 'Download' icon (a floppy disk) in the 'My Mixtures' table, which is also circled in red. The 'File Download' dialog box is open, showing the 'Save As' window with the file name 'Mixture_my highly enriched uranium, HEU.xml' and the file type 'XML Document'.

My Mixtures | Edit | Upload | Sample Mixtures

Name: my highly enriched uranium, HEU

Description: isotopic composition: 0.77% U-234, 90.20% U-235, ...

Save Mixture | Reset | Cancel

User defined nuclide mixtures

Mixture	Date modified	Download	Delete
(create, upload a new Mixture)			
my highly enriched uranium, HEU	06.05.2011, 14:13:37		
HEU, highly enriched uranium	06.05.2011, 13:32:54		
My Uranium			
My U232+Co60 Mixture			
Natural Uranium			
Decay of 1 Grams of 3			
U232+Co60			
Transuranics in 1 ton			
Natural Thorium			
Cs137 + Ba137m			
All Mixtures (10)			

File Download

Save in: Mixtures

Save As: Mixture_my highly enriched uranium, HEU.xml

File name: Mixture_my highly enriched uranium, HEU.xml

Save as type: XML Document

Save | Cancel

Exercise:

1. Create a nuclide mixture containing 100 atoms for natural uranium with the following composition:

U-238: 99.2742 atoms,

U-235: 0.7204 atoms,


U-234: 0.0054 atoms

2. Rescale the results to 1 kg (click on "Total" in the grid to rescale the results)

Nuclear Science Training Course with Nucleonica

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Mass Activity Converter

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Co60

10.47 m 5.27 y

Mass Activity Converter

27 Cobalt

Current Chart: Karlsruhe

Element: Co Mass: 60  Mixture selector

Converter Options Mixture details

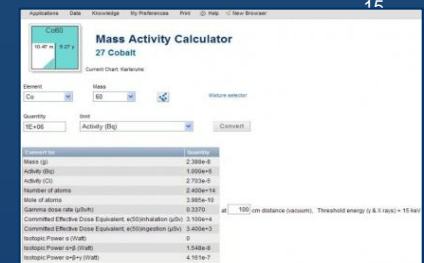
Quantity: 1E+06 Unit: Activity (Bq) 

Convert

Physical quantity	Magnitude	Unit
Mass	M = 2.388e-8	g
Activity	A = 2.703e-5	Ci
Number of atoms	N = 2.400e+14	atom
Number of moles	N/N _A = 3.985e-10	mole
Exposure rate at 2 m	X = 0.07522	μGy/h in air
Equivalent gamma dose rate in tissue at 2 m	Ḣ = 0.08425	μSv/h
Committed Effective Dose Equivalent, inhalation	E ₅₀ = 3.100e+3	mrem
Committed Effective Dose Equivalent, ingestion	E ₅₀ = 340.0	mrem
Isotopic Power α	P _α = 0	Watt
Isotopic Power α+β	P _{αβ} = 1.548e-8	Watt
Isotopic Power α+β+γ	P _{αβγ} = 4.161e-7	Watt

Learning Objectives

- To become familiar with basic radiological units becquerel (Bq), curie (Ci), sievert (Sv), etc.
- To become familiar with basic radiological quantities such as activity, specific activity, dose rate, etc.
- To understand the relationships between the basic units
- To get to know how to use the Mass Activity Converter module in Nucleonica to convert between different units. This requires familiarity with the Glossary, Help, Calculator
- To strengthen the above understanding through a series of problems and exercises.



The mass activity calculator is a popular tool for conversion between different physical quantities (e.g. mass, activity, number of atoms, etc.).

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- external and internal dosimetry quantities such as the gamma dose rate (where the distance is required)
- the committed effective doses for inhalation and ingestion.
- the amount of heat generated – isotopic power – through radioactive decay for α , $\alpha+\beta$, $\alpha+\beta+\gamma$.

In the this example, the nuclide Co-60 is selected. A different nuclide can be selected from the element and mass drop-down menus. The default source strength is 1 MBq. In the unit drop-down menu, the source strength is shown in becquerel (Bq), curie (Ci), number of atoms, etc. The user can also select a previously defined nuclide mixture (by clicking on the Mixture selector). Further information is given in the Nucleonica wiki.

Co60

10.47 m
5.27 y

Mass Activity Converter

27 Cobalt

Current Chart: Karlsruhe

Element

Co

Mass

60

Mixture selector

Converter

Options

Mixture details

Quantity

1E+06


Unit

Activity (Bq)

Convert

Physical quantity	Magnitude	Unit
Mass	M = 2.388e-8	g
Activity	A = 2.703e-5	Ci
Number of atoms	N = 2.400e+14	atom
Number of moles	N/N _A = 3.985e-10	mole
Exposure rate at 2 m	X = 0.07522	μGy/h in air
Equivalent gamma dose rate in tissue at 2 m	Ḣ = 0.08425	μSv/h
Committed Effective Dose Equivalent, inhalation	E ₅₀ = 3.100e+3	mrem
Committed Effective Dose Equivalent, ingestion	E ₅₀ = 340.0	mrem
Isotopic Power α	P _α = 0	Watt
Isotopic Power α+β	P _{αβ} = 1.548e-8	Watt
Isotopic Power α+β+γ	P _{αβγ} = 4.161e-7	Watt

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Help:Mass Activity Converter

Level: Introductory, Intermediate

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Nucleonica's Mass Activity Converter

The mass activity converter is a popular tool for conversion between different physical quantities (e.g. mass, activity, number of atoms, etc.). A particularly useful feature is that in addition to single nuclides, the mass activity calculator can also be applied to nuclide mixtures. These nuclide mixtures can be created with the [Nuclide Mixtures](#) module. The Convert box shows the full list of quantities. In addition to the standard list (mass, activities, etc.), conversions can also be made using:

- external and internal dosimetry quantities such as the [gamma dose rate](#) (where the distance is required)
- the [committed effective doses](#) for inhalation and ingestion.
- the amount of heat generated – [isotopic power](#) – through radioactive decay for α , $\alpha+\beta$, $\alpha+\beta+\gamma$.

In the above example, the nuclide Co-60 is selected. A different nuclide can be selected from the element and mass drop-down menus. The default source strength is 1 MBq. In the unit drop-down menu, the source strength is shown in becquerel (Bq), curie (Ci), number of atoms, etc. The user can also select a



The screenshot shows the 'Mass Activity Converter' interface. At the top, it displays 'Co60' and '27 Cobalt'. Below this, there are dropdown menus for 'Element' (set to 'Co') and 'Mass' (set to '60'). To the right of these is a 'Mixture selector' icon. Below the dropdowns are three tabs: 'Converter' (active), 'Options', and 'Mixture details'. Under the 'Converter' tab, there are input fields for 'Quantity' (set to '1E+06') and 'Unit' (set to 'Activity (Bq)'). A 'Convert' button is located to the right of the unit dropdown. At the bottom, there is a table with three columns: 'Physical quantity', 'Magnitude', and 'Unit'. The table contains three rows: 'Mass' with magnitude 'M = 2.388e-8' and unit 'g'; 'Activity' with magnitude 'A = 1.000e+6' and unit 'Bq'; and 'Number of atoms' with magnitude 'N = 2.400e+14' and unit 'atom'.

In this section, the basic relationships between number of atoms, mass, and activity, are developed. From these basic quantities, additional quantities such as the gamma dose rate, the effective doses for inhalation and ingestion and the isotopic powers can be obtained.

For an amount of material with mass in grams given by $Mass(g)$, the number of atoms N is given by

$$\frac{N}{N_A} = \frac{Mass(g)}{M} \quad \text{or} \quad N = Mass(g) \cdot \frac{N_A}{M}$$

Where N_A is Avogadro's number or Avogadro's constant ($N_A = 6.002214179 \times 10^{23}$), and M is the atomic mass of the nuclide. This basic relationship follows from the fact that 1 mole of any material contains Avogadro's number of atom.

The conversion of number of atoms to the number of moles is given by

$$\text{Number of moles} = \frac{N}{N_A}$$

The conversion from number of atoms to activity, and vice versa, is obtained using

$$Activity(Bq) = k \cdot N = \ln 2 \cdot N / \tau$$

$$Activity(Ci) = Activity(Bq) / 3.7 \cdot 10^{10}$$

Where k , and τ are the decay constant and half-life respectively of the nuclide. Combining the above relations, it follows that the relation between activity and mass is given by

$$Activity(Bq) = (\ln 2 / \tau) \cdot Mass(g) \cdot N_A / M$$

Derived Quantities

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From the activity A , additional important quantities such as the gamma dose rate, the committed effective doses and the isotopic powers can be derived. The relations used in the Mass Activity Calculator are given below. For more details on the meaning and derivation of these quantities, the reader should follow the links.

The gamma dose rate in tissue, $\frac{dH}{dt}$, (follow the link for the derivation) is given by

$$\frac{dH}{dt} = A / (4\pi R^2) \cdot \sum_i (E_i \cdot P_i \cdot (\mu_i / \rho)_i^{tis})$$

From the above relation, it can be seen that the gamma dose rate depends on the distance R from the source. For this reason, for the evaluation of the gamma dose rate, the distance must also be specified. A default distance of 100 cm is used. In addition, the threshold energy must also be specified. The default value of the threshold energy is 15 keV. Other quantities required for the calculation are the energies E_i and emission probabilities P_i of the radiation, and the mass absorption coefficient $(\mu/\rho)_i^{tis}$ in tissue. The summation index i refers to all the individual gamma and x-ray energies.

The committed effective doses are given by

$$\text{Committed effective dose for inhalation, } E_{inh}(50) = e_{inh}(50) \cdot \text{Activity}(Bq)$$

$$\text{Committed effective dose for ingestion, } E_{ing}(50) = e_{ing}(50) \cdot \text{Activity}(Bq)$$

Finally, the isotopic power is given by

$$\text{Isotopic Power } (\alpha) = A \cdot |E_\alpha|$$

$$\text{Isotopic Power } (\alpha + \beta) = A \cdot |E_\alpha + E_\beta|$$

$$\text{Isotopic Power } (\alpha + \beta + \gamma) = A \cdot |E_\alpha + E_\beta + E_\gamma|$$

Nuclide Selector

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In the Mass Activity Calculator, the nuclide Co-60 is selected by default. A different nuclide can be selected from the element and mass drop-down menus.

The Nuclide Chart Button shows the location of the selected nuclide on the nuclide chart. To the right of this, the nuclide mixture link can be used to select a nuclide mixture.

The source strength can be specified by using the drop-down menus (see the following section). The default source strength is 1 MBq.

In the Unit/Quantity drop-down menus, the source strength is shown in Becquerel (Bq), Curie (Ci), Number of Atoms, etc. This can then be converted to other units.



The screenshot shows the 'Mass Activity Calculator' interface. At the top left, a small nuclide chart highlights the position of Co-60, with its half-lives '10.47 m' and '5.27 y' indicated. The main title is 'Mass Activity Calculator' with '27 Cobalt' below it. A label 'Current Chart: Karlsruhe' is present. The 'Element' dropdown is set to 'Co' and the 'Mass' dropdown is set to '60'. To the right of these is a 'Nuclide chart' button (represented by a small grid icon) and a 'Mixture selector' link. Below the element and mass fields, the 'Quantity' is set to '1E+06' and the 'Unit' dropdown is set to 'Activity (Bq)'. A 'Convert' button is located at the bottom right of the form.

Unit/Quantity Selector

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The input unit can be changed in the Unit drop down menu. The default unit is Bq. Had the value Curie been selected, on pressing the Convert button, the corresponding values in grams, Bq, number of atoms etc. are shown in the Convert to/Quantity table.

Quantity

1E+06

Unit

Activity (Bq)
Mass (g)
Activity (Bq)
Activity (Ci)
Activity (dpm)
Number of atoms
Mole of atoms
µGy/h exposure rate (in air)
mR/h exposure rate
C/kg/h exposure rate
µSv/h gamma dose rate
mrem/h gamma dose rate
µSv e(50)inh
µSv e(50)ing
mrem e(50)inh
mrem e(50)ing
Watt (alpha)
Watt (alpha+beta)
Watt (alpha+beta+gamma)

Once the unit and quantity have been selected in the Unit/Quantity Selector, the source strength in other units is given in the Convert to / Quantity table, by pressing the Convert button. The results are shown for 1 MBq Co-60.


Physical quantity	Magnitude	Unit
Mass	M = 2.388e-8	g
Activity	A = 2.703e-5	Ci
Number of atoms	N = 2.400e+14	atom
Number of moles	$N/N_A = 3.985e-10$	mole
Exposure rate at 2 m	$\dot{X} = 0.07522$	µGy/h in air
Equivalent gamma dose rate in tissue at 2 m	$\dot{H} = 0.08425$	µSv/h
Committed Effective Dose Equivalent, inhalation	$E_{50} = 3.100e+4$	µSv
Committed Effective Dose Equivalent, ingestion	$E_{50} = 3.400e+3$	µSv
Isotopic Power α	$P_\alpha = 0$	Watt
Isotopic Power α+β	$P_{\alpha\beta} = 1.548e-8$	Watt
Isotopic Power α+β+γ	$P_{\alpha\beta\gamma} = 4.161e-7$	Watt

Nuclide Mixtures

The mass activity calculator can also be used for nuclide mixtures. In the diagram shown, the nuclide mixture “natural uranium” has been selected. This mixture has been previously created in the Nuclide Mixtures module for 1 mole (of atoms) of natural uranium containing

0.9927 mole U-238,
 7.114×10^{-3} mole U-235 and
 5.310×10^{-5} mole U-234.

As can be seen, even 1 mole of atoms of natural uranium, with a mass of 238 gram and activity of almost 6 MBq (without daughters), has a negligible gamma dose rate and heat emission rate (isotopic power).



Mass Activity Converter

Natural Uranium

Mixture

Natural Uranium

Nuclide selector

ConverterOptionsMixture details

QuantityUnit

1Mole of atoms

Convert

Physical quantity	Magnitude	Unit
Mass	M = 238.0	g
Activity	A = 5.981e+6	Bq
Number of atoms	N = 6.022e+23	atom
Number of moles	N/N _A = 1.000	mole
Exposure rate at 2 m	\dot{X} = 6.523e-4	μGy/h in air
Equivalent gamma dose rate in tissue at 2 m	\dot{H} = 7.306e-4	μSv/h
Committed Effective Dose Equivalent, inhalation	E ₅₀ = 5.199e+7	μSv
Committed Effective Dose Equivalent, ingestion	E ₅₀ = 2.811e+5	μSv
Isotopic Power α	P _α = 4.356e-6	Watt
Isotopic Power α+β	P _{αβ} = 4.368e-6	Watt
Isotopic Power α+β+γ	P _{αβγ} = 4.373e-6	Watt

Exercises Mass Activity Converter

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1. **Calculate the specific activities of C-14 and S-35?** ($1.7\text{E}11$ Bq/g (4.5 Ci/g), $1.6\text{E}15$ Bq/g ($4.3\text{E}4$ Ci/g)).
2. **The activity of Sr-90 is 18,000 transformations per minute. What is the mass of Sr-90?** (Ans. mass = $5.87\text{E}-11\text{g}$).
3. **Six grams of carbon from a piece of wood found in an ancient temple are analyzed and found to have an activity of 10 transformations per minute per gram of carbon. How many atoms of C-14 are present in the sample and what is their mass?** ($2.6\text{E}11$ atoms, mass = $6.0\text{E}-12$ g)
4. **What is the dose rate from a 100 MBq source of Co-60 at 2m distance?** (8.4 $\mu\text{Sv/h}$)
5. **The concentration of potassium (K) in humans is about 1.7 g/kg. What mass of potassium does an average person (weight 80 kg) contain?** (136 g).
 - **What is the atomic weight of potassium?** Hint: see the sample mixture in the Nuclide Mixtures (39.0983)
 - **What is the total number of atoms of potassium?** Hint: use the atomic weight ($2.09\text{E}24$ atoms)
 - **What is the total number of atoms of K-40?** Hint: use the abundance of K-40 (0.0117 atom %) given in the Mass Activity Converter or in the Datasheets ($2.45\text{E}20$ atoms K-40)
 - **What is the mass and activity of K-40 in this person?** ($1.62\text{E}-2$ g, 4.2 kBq).